MICROSAT SYSTEMS

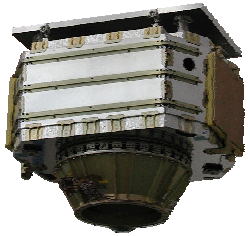
MicroSat Systems

2003 Small Payload Rideshare Conference

June 10-11, 2003

KSC Visitor Center

MicroSat Systems Products

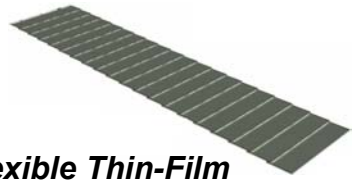


Capabilities Include:

- *Mission Design*
- *Systems Engineering*
- *Spacecraft Design*
- *Assembly, Integration & Test*
- *Launch Vehicle Integration*
- *Mission Operations*

Small Satellites

- Low Cost: <$10M Recurring
- Lightweight: Up to 500 Kg
- Rapid Development: 18-24 Months
- High Performance: 3-Axis Stabilized, Inter-satellite Link, Formation Flying

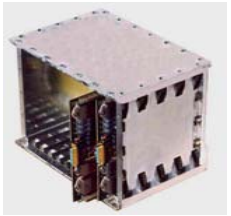


- *Flexible Thin-Film Photovoltaics*
- *High Radiation Tolerance*

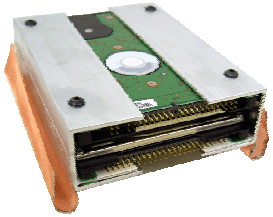
Satellite Subsystems

- Solar Arrays
  - Low Cost: $500/watt
  - High Specific power: 150 watt/Kg
  - Small Stowage Volume: 45 Kw/m^3
- Composite Structures
  - Lightweight: <1 kg Chassis
  - Compact Footprint: 3UcPCI
  - High Watt Density Capability
- Micro-Mass Storage Module (MMSM)
  - 160 GByte Hard Drive Memory for Space Applications
  - 800 Mbps data rate
  - 50% Mass/Cost Savings over Solid State Memories

Graphite / Polycyanate Sandwich Panels



Micro-Mass Storage Module



Winner of 2002 Tibbetts Award

Prestigious national award made annually to companies judged to exemplify the very best in Small Business Innovative Research achievement.

Role of Micro-Satellites

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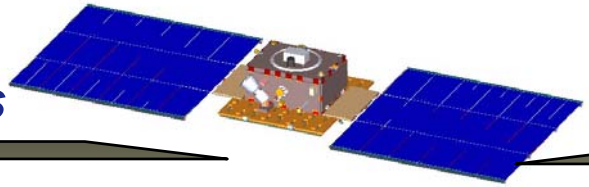
Military Applications

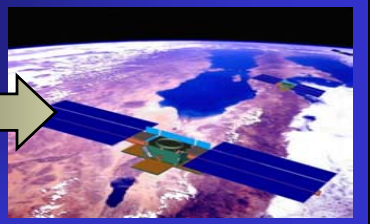


Commercial Applications

Highly Capable Micro-Satellites (up to 500kg)

Same mission with smaller, lighter, more affordable satellites

GPS IIR
970 kg (dry)



Micro-GPS
<100kg

New missions enabled

Logistics / Control

Satellite Clusters

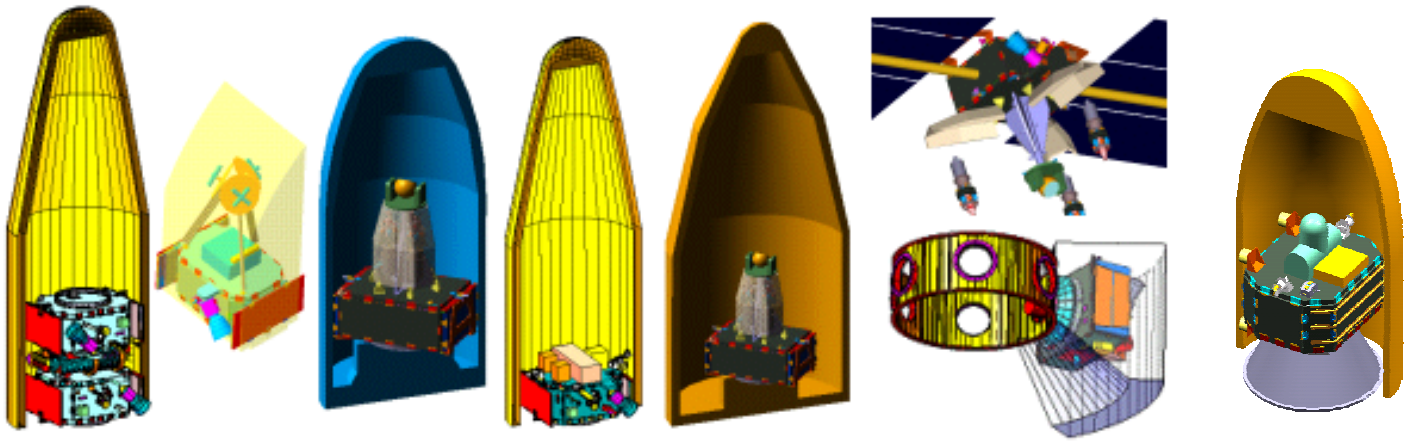
Tactical Space

- Specialized Communications Services (Voice, Data)
- Earth Observation (EO) and Remote Sensing
- Space Science
- Technology Demonstration & Verification
- Education and Training

Micro-Satellites Bring Affordable New Capabilities to Revolutionize Space Missions

S/C Adaptable to Many LV's

- **S/C Conform to Multiple Launch Vehicles**
  - Easy fit In Existing & In Development LV's
  - Launch as Primary, Secondary, Multi-Launch
- **Ability to Reconfigure for Multiple Missions**
  - Communications
  - Remote Sensing/Imaging
  - Space Weapons Platform
  - Formation Flying



MSI Bus Evolution

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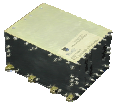
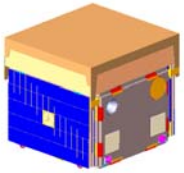
2000	2005	2010

TechSat 21

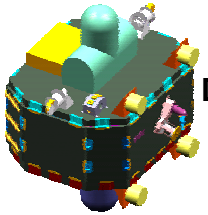
Add Common processes & Subsystems



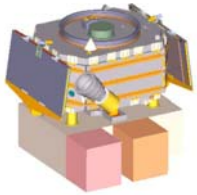
Increase Utility



Team Encounter



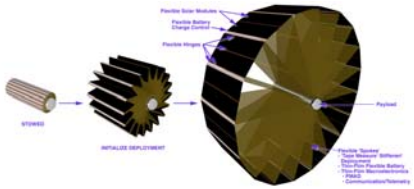
DARPA Flight Experiment

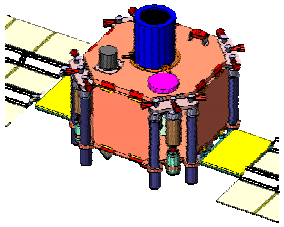


HSI Mission

SAR Mission

Rapid Response





TechSat 21 Overview

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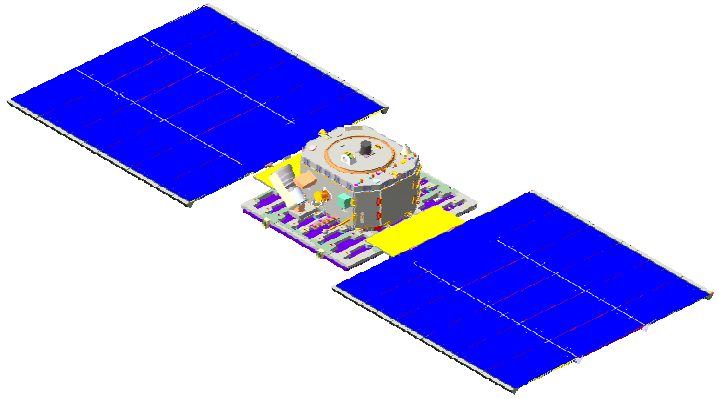
Mission Overview

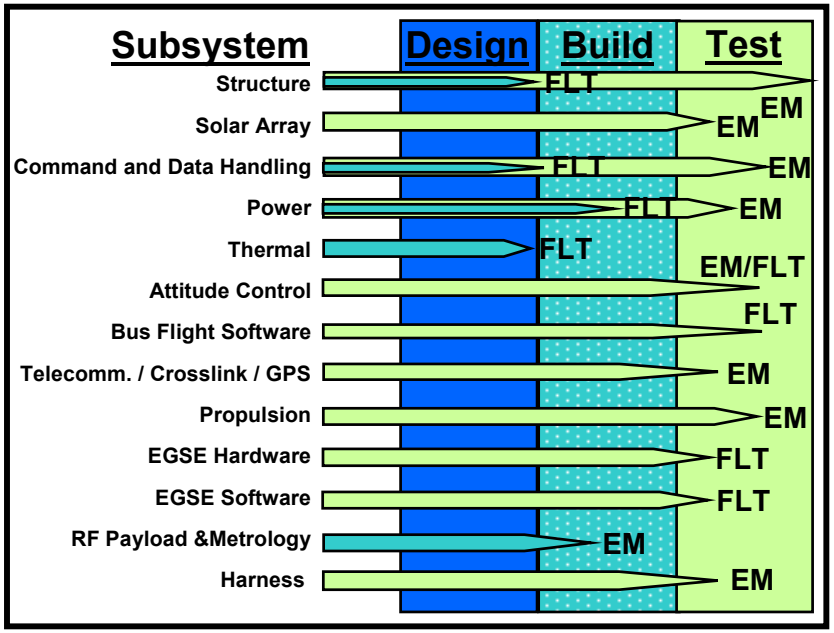
- US AFRL program with MSI as the Prime Integrator
- Three Satellites Flying in Very Close Formation
- Collaborative Sparse Aperture Radar
- Validate Microsatellite Technologies

Spacecraft Overview

- Compatible with EELV Secondary Payload, Pegasus and Other LV's
- Successful Critical Design Review in October '02
- Integration & Test Started January '03
- $3M Congressional add in '03
- Exploring Transition of Program from AFRL in '04



Development Status



TechSat 21 Space Vehicle

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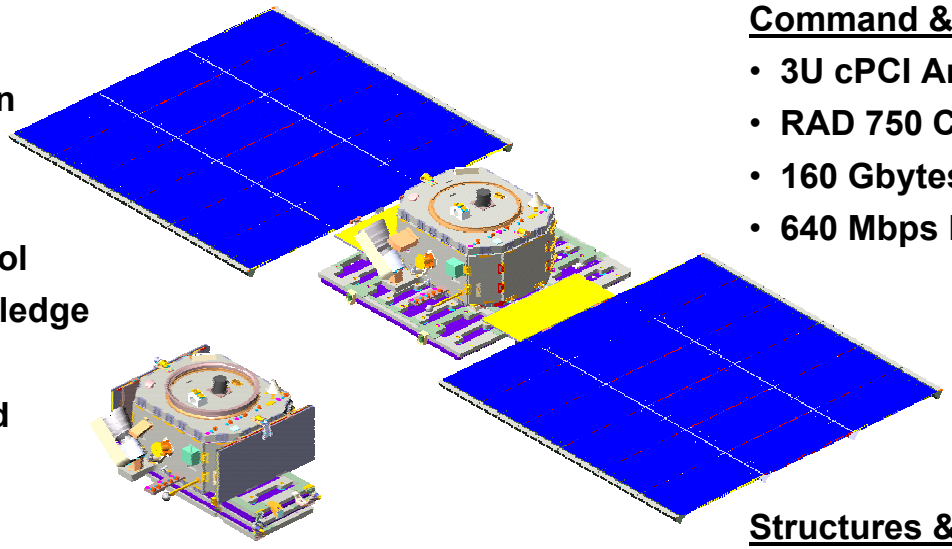
One of the Most Capable Spacecraft Buses Under 100 kg Ever Developed

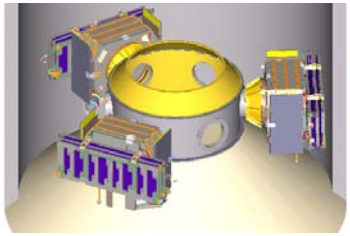
Space Vehicle Mass
- 88 kg Bus
- 79 kg Payload Allocation

Attitude Control
- 0.10 deg Pointing Control
- 0.02 deg Pointing Knowledge
- 3-Axis Stabilized
- Zero Momentum Biased



Command &Data Handling
- 3U cPCI Architecture
- RAD 750 CPU
- 160 Gbytes Mass Storage
- 640 Mbps Data Transfer Rate

Flight Software
- Command and Telemetry
- ADCS
- Safe Hold
- OSE OS



Structures & Mechanisms
- Gr/Pc Composite Panels
- NADIR Pointing Payload Deck
- G&H Burn Wire Sep Devices

Electrical Power
- 28 V Unregulated
- 433 WOAP; 2380 W Peak
- 150 W/kg CIGS Solar Wings
- 150 W-Hr/kg LI Polymer Battery

Telemetry, Tracking, & Command
- 50 Kbps Encrypted S-Band Uplink
- 500 Kbps S-Band; 128 Mbps X-Band
- 160 Kbps S-Band Intersatellite Link
- On-Board GPS Receiver

Advanced Micro-satellite Technologies

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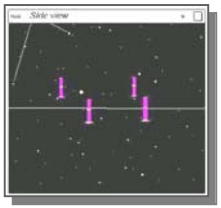
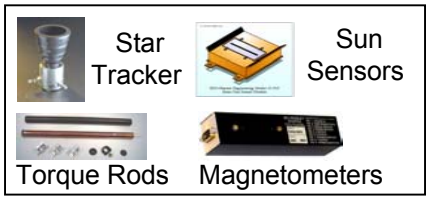
Precision Metrology
- Differential Carrier Phase GPS
- Ultra-Stable Oscillator
- 160 kbps Intersatellite Datalink



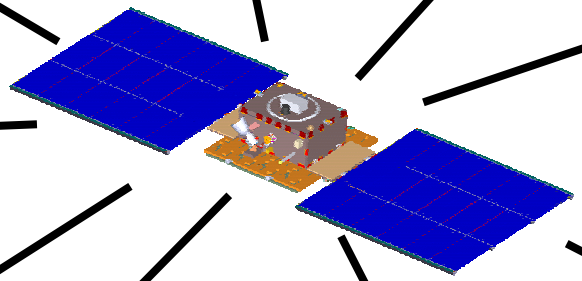
Cluster Management
- Formation Flying Autonomous C^2 of Cluster
- Distributed Aperture Processing

Lithium Polymer Battery
-150 W-hr/kg
- 175 W/kg

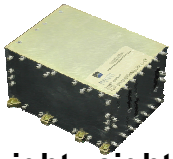
Thin-Film Photovoltaic Solar Array
- 150 W/kg
- Small Stowage Volume
- Lightweight Deployment Mechanism



3 Axis Attitude Control
- Miniature Reaction Wheels
- 0.02 Degree Pointing Knowledge



Xe Hall Effect Thruster
- 1200 Sec ISP



Lightweight Electronics Chassis
- < 1 kg Chassis
- 3U cPCI Avionics

On-Board Mass Storage
- 160 GBytes @ 4 kg
- Space Qualified Hard Drive Enclosure

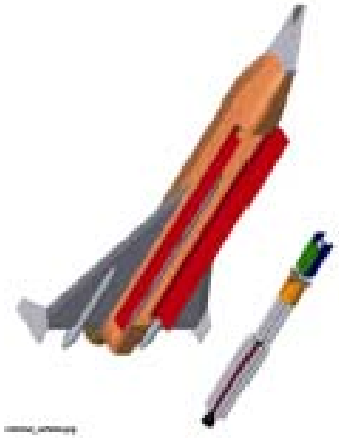
High Speed On-Board Processor
- 160 MIP RAD 750

ESA Antenna Array

Microsats Enabling Rapid Response

Spacecraft Enablers

- Computer Industry Procurement Style
- Launch on Demand (LOD) Architecture
- Web Based Integration and Test
- New Spacecraft Design Approaches

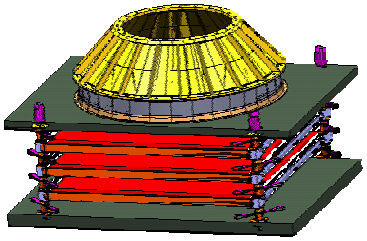


Launch On Demand Being Enabled

- Military: RASCAL & F-15
- Ground/Sea Mobile Launchers

System Utility

- Small spacecraft to any LEO inclination
- Rapid and Affordable Access
- Able to quickly respond to new situations



Procurement: Computer Industry

Computer Industry

Customer Provides:
- Functions to Perform
- Peripherals w/ Expandability
- Available Funds & Schedule

Distributor Provides:
- Appropriate Products
- AI&T
- Load S/W and Checkout

Customer:
- Integrates Peripherals
- Loads Application S/W
- Performs Checkout Using On-Line Tech Support

Inventory
- System Components
- Peripheral or Payload Specs
- Tower or Launch Systems

Space Industry

Customer Provides:
- Mission Requirements
- Payloads w/ Expandability
- Available Funds & Schedule

Distributor Provides:
- Appropriate Products
- AI&T
- Load S/W and Checkout

Customer:
- Integrates Payloads on Bus
- Integrates S/C on LV
- Performs Checkout Using On-Line Tech Support

LOD Architecture

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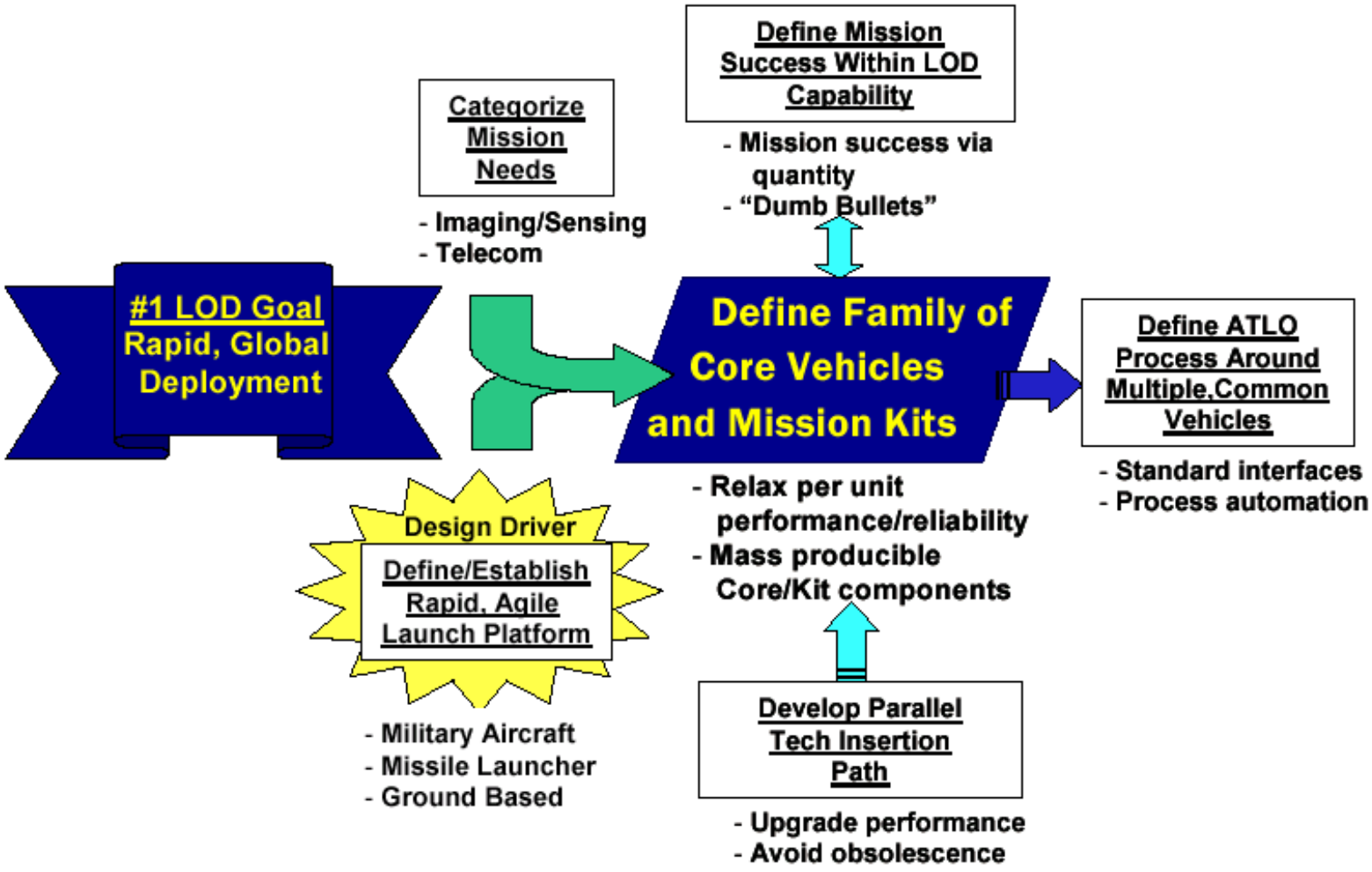
Build Missions around family of "Core" vehicles



Web Based Integration and Test

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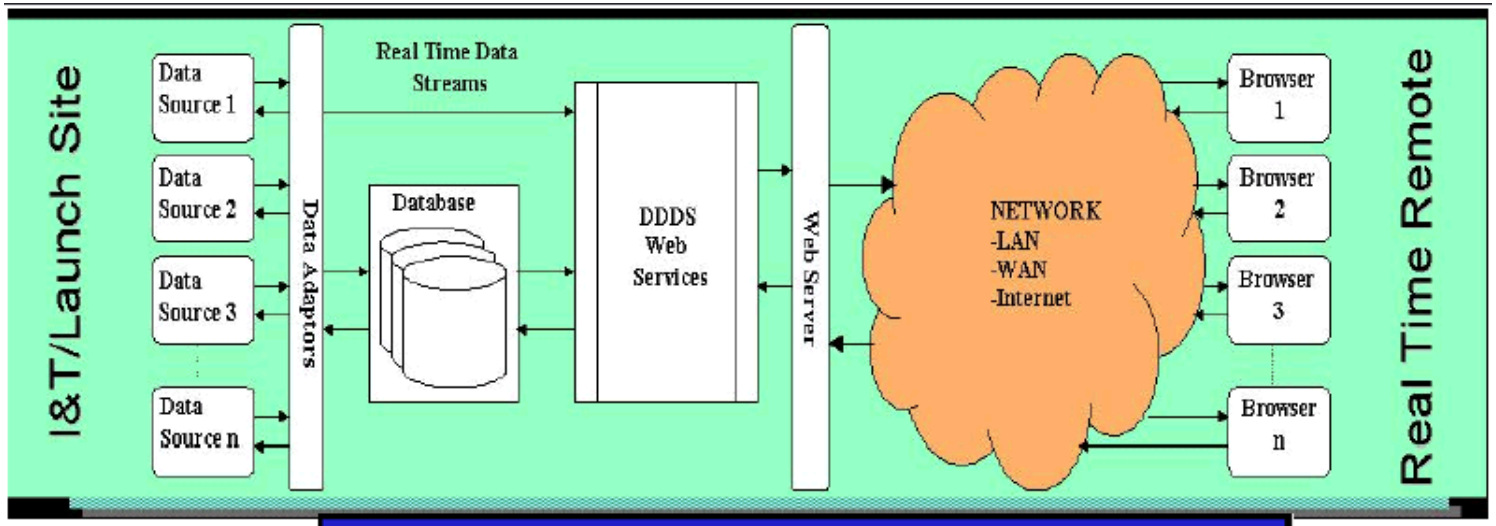
Enables Real-Time Multi-Tasking of Remote Personnel



Features

- Engineering Support From Desk Work Station, While Out of Office, Emergency Off Hours
- Data to Sub-Contractors/ Customers

Benefits

- Maximize Effciency of Shared Resoures
- Reduce Labor/Travel Cost/Schedule

New Spacecraft Design Approaches

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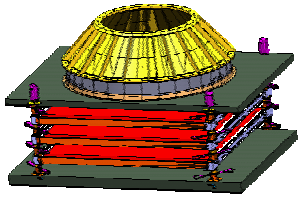
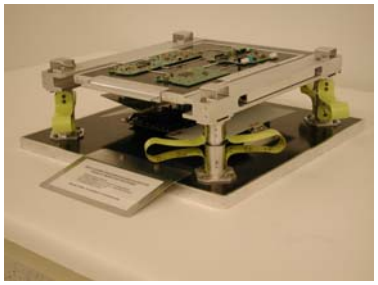
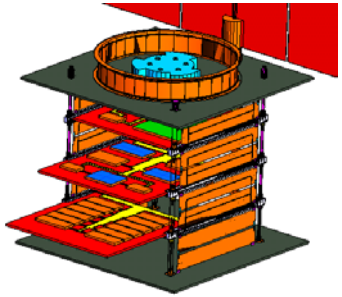
- **Example: Collapsible Structure**
  - Utilize emerging MEMS technology
  - Compact Bus for Launch Allows Easier Multiple Spacecraft Launch Capabilities
  - Compact Bus reduces distance of spacecraft CG from separation plane for reduced launch loads, thus reduced structural mass
  - Integrates Computer Build Methodology
  - Expansion allows for "On Orbit" addition of larger payload/avionics
  - Expansion allows for greater moment arm for propulsion reaction thus conserving fuel

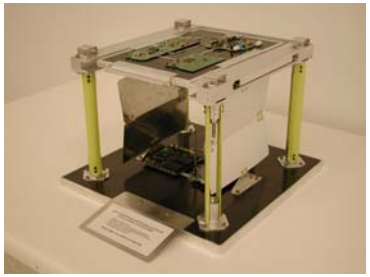
Launch Configuration





Deployed Configuration





Summary

- MSI Preparing to Meet Responsive Space Needs
- Automated, Standardized Integration and Test Processes, Smart Interfaces
- Highly Maneuverable small satellites